National Aeronautics and Space Administration

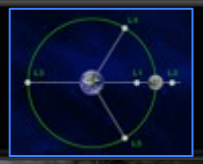
The Space Launch System: *NASA's Exploration Rocket*

Christopher Blackerby

June 3, 2013





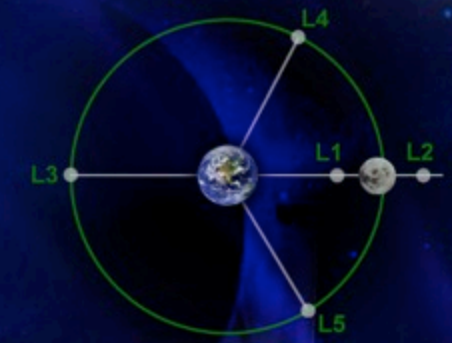



Space Launch System

“To reach for new heights…

and reveal the unknown so that what we do and learn will benefit all humankind.”

National Aeronautics and Space Administration



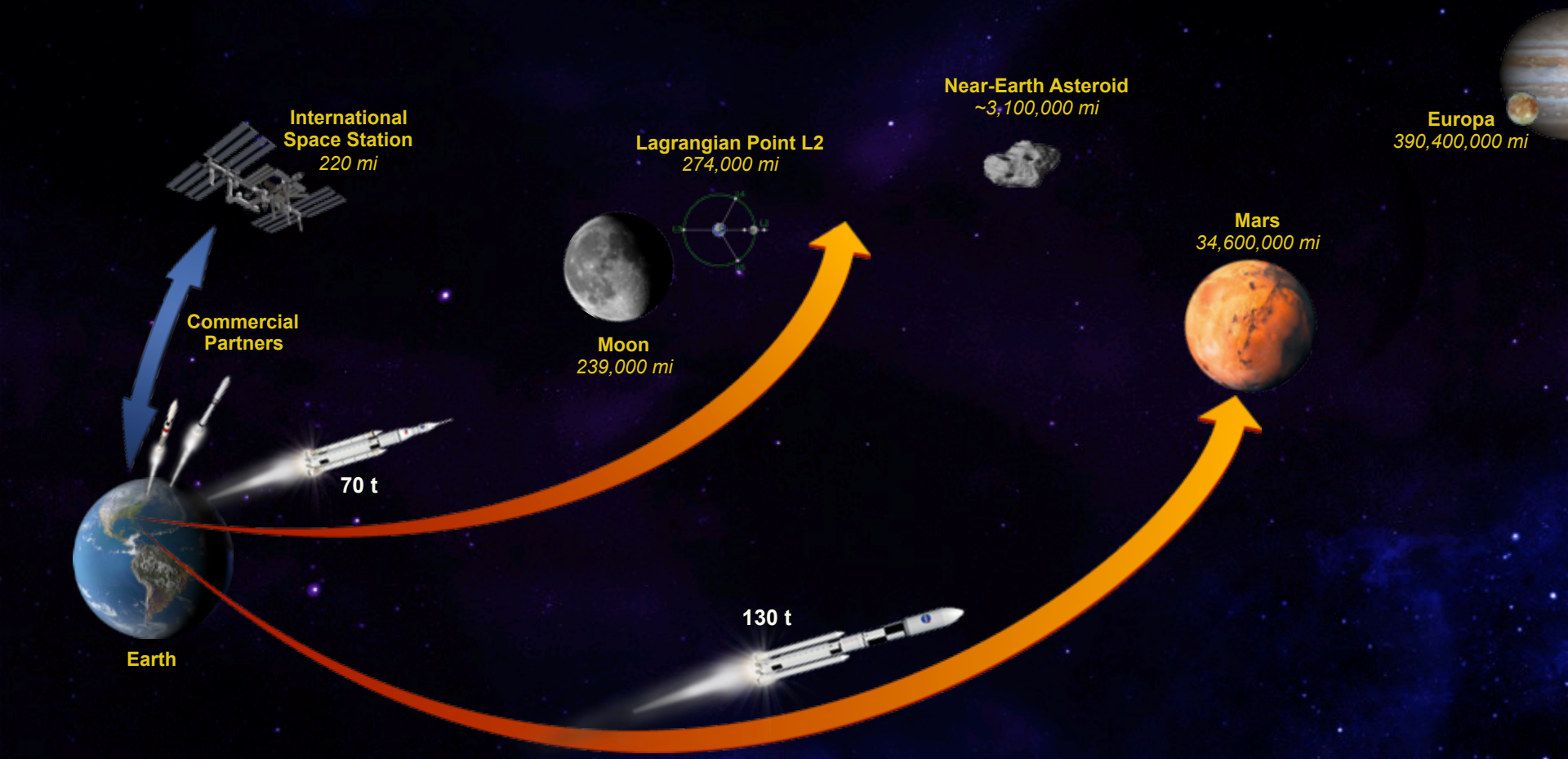
SLS Launches in 2017

- Extend & sustain human activities across the solar system.
- Expand scientific understanding of the Earth & the universe in which we live.

NASA 2011 Strategic Plan

The Next Great Ship

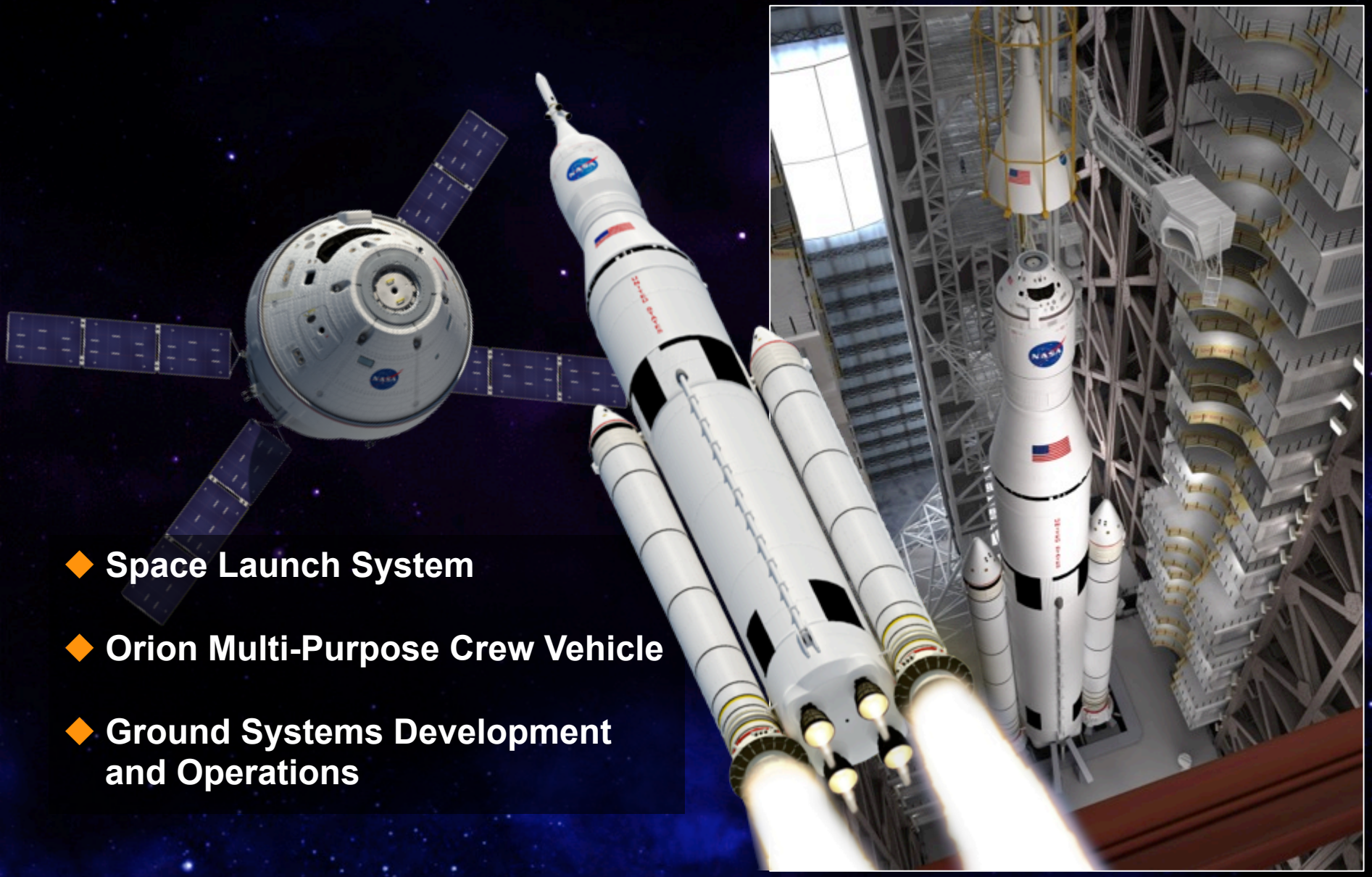
The Future of Exploration



The Space Launch System [will] be the backbone of its manned spaceflight program for decades. It [will] be the most powerful rocket in NASA's history…and puts NASA on a more sustainable path to continue our tradition of innovative space exploration.

President Obama's Accomplishments for NASA
May 22, 2012

Exploration Systems Development



- Space Launch System
- Orion Multi-Purpose Crew Vehicle
- Ground Systems Development and Operations

SLS Launch Schedule

2013 2014 2015 2016 2017 2018 2019 2020 2021 2022

Asteroid Detection, Characterization, & Selection Segment

SST

PS-2

Geosynchronous Earth Orbit-hosted payload detection

Enhanced Ground Assets & Initial candidates

Final target selection

Asteroid Redirection Segment

NOTIONAL – SUBJECT TO CHANGE AS MISSION CONCEPT EVOLVES

Mission Launch & Solar Electric Propulsion Demo

Asteroid Rendezvous & Capture

Asteroid Maneuver to Cis-lunar Space

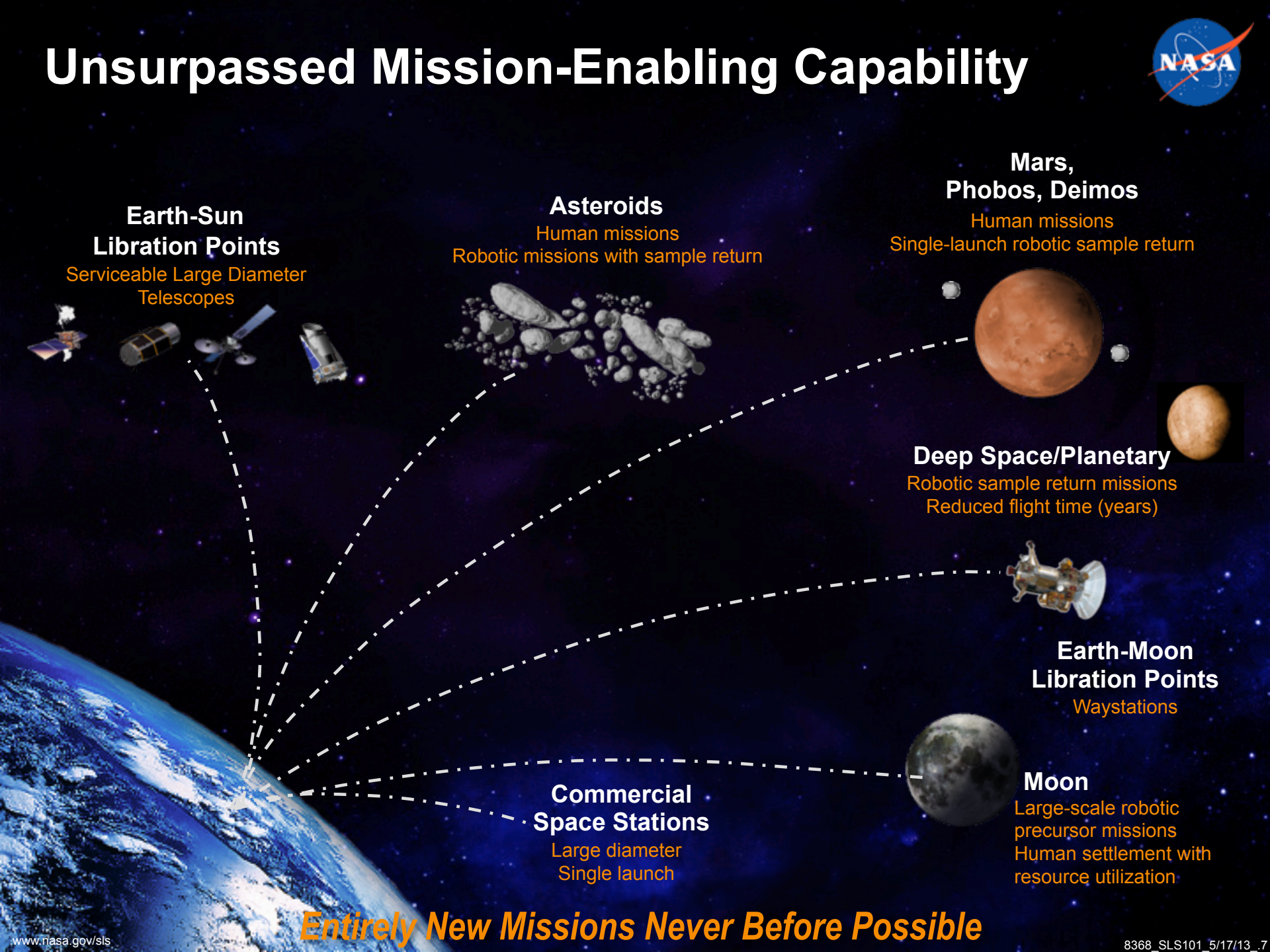
Orion & SLS Crewed Asteroid Exploration Segment

Exploration Flight Test: Un-crewed Orion Flight in Earth Orbit

Exploration Mission-1 (EM-1): Un-crewed Orion Test Flight Beyond the Moon

EM-2: Crewed Orion Flight Beyond the Moon

Unsurpassed Mission-Enabling Capability



Entirely New Missions Never Before Possible

Mars: Making the Ultimate Goal a Reality

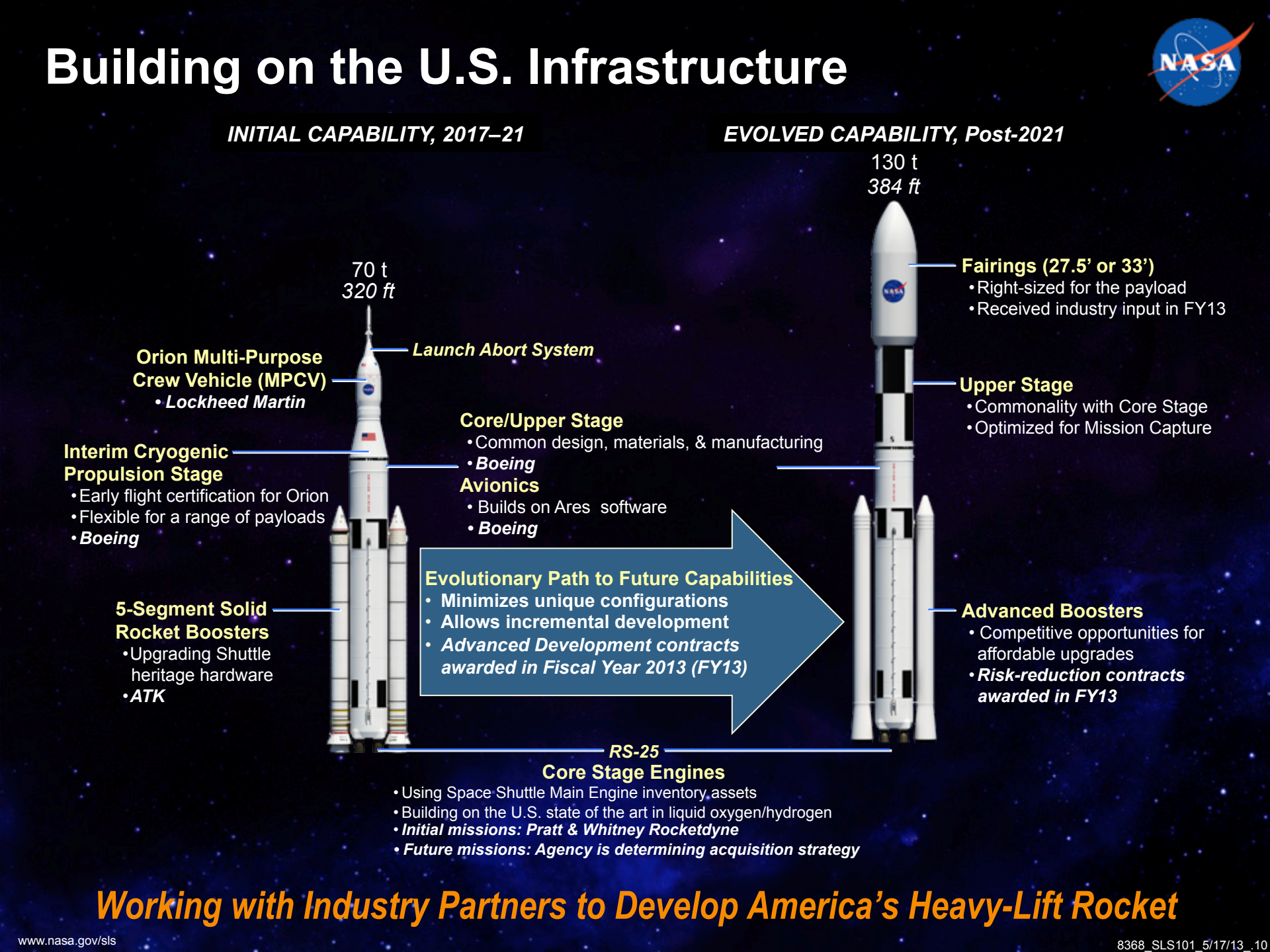
Mars Landing: Heading for the High Ground
Courtesy of Dan Durda

SLS Driving Objectives

- **Safe**
  - Human-rated to provide safe and reliable systems
  - Protecting the public, NASA workforce, high-value equipment and property, and the environment from potential harm
- **Affordable**
  - Maximum use of common elements and existing assets, infrastructure, and workforce
  - Constrained budget environment
  - Competitive opportunities for affordability on-ramps
- **Sustainable**
  - Initial capability: 70 metric tons (t), 2017–2021
    - Serves as primary transportation for Orion and human exploration missions
  - Evolved capability: 105 t and 130 t, post-2021
    - Offers large volume for science missions and payloads
    - Reduces trip times to get science results faster
    - Minimizes risk of radiation exposure and orbital debris impacts

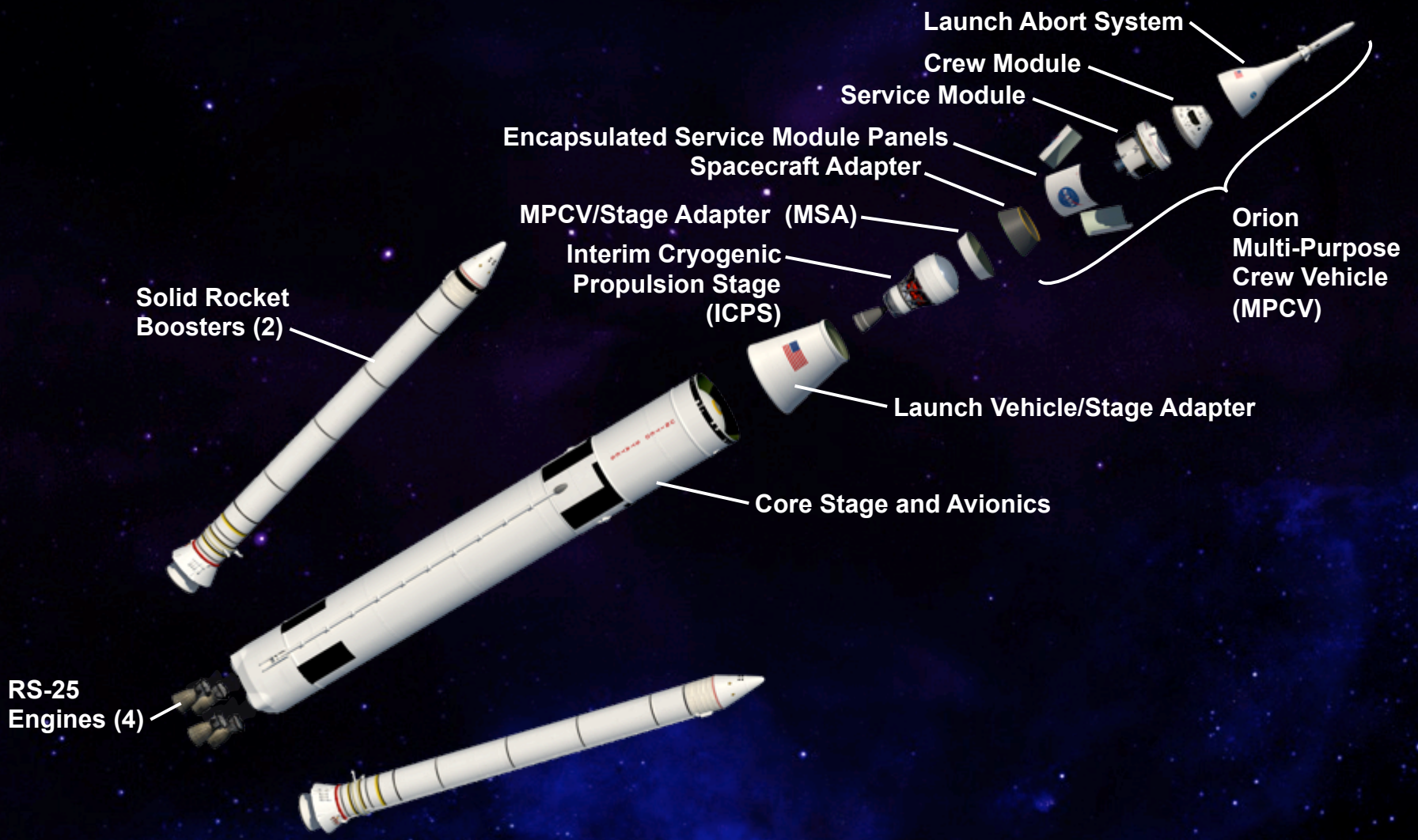
Platform for Missions Beyond Earth's Orbit

Building on the U.S. Infrastructure



Working with Industry Partners to Develop America's Heavy-Lift Rocket

SLS 70 metric ton Expanded View

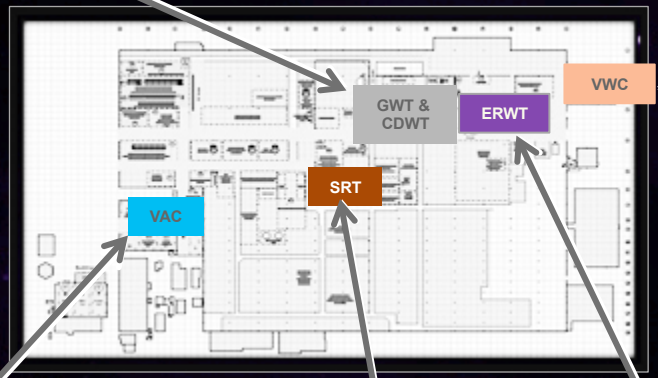


Initial Capability Stands on the Shoulders of Legacy Systems

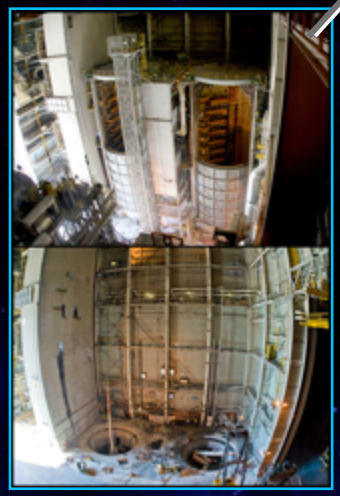
Core Stage Progress


Circumferential Dome Weld Tool (CDWT)

Next Big Steps	
Tooling Availability	May 2013 - Enhanced Robotic Weld Tool (ERWT) June 2013 - Vertical Weld Center (VWC)



Vertical Weld Center (VWC)


Vertical Assembly Center (VAC)

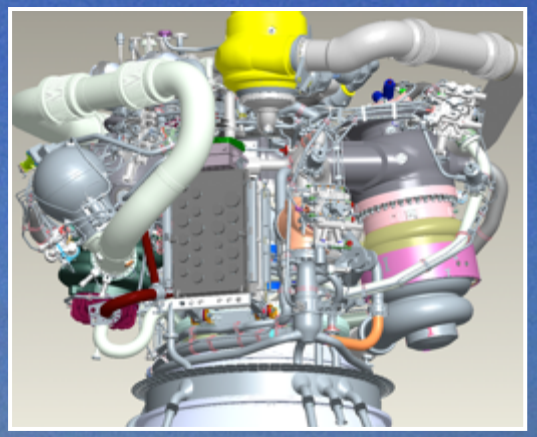
Manufacturing Layout
Michoud Assembly Facility
(New Orleans, LA)


Segmented Ring Tool (SRT)


Enhanced Robotic Weld Tool (ERWT)

RS-25 Core Stage Engines In Stock

- Inventory at Stennis Space Center for first 4 SLS flights
- Utilizing proven, existing hardware supports SLS safety and affordability goals
- Preparations under way for RS-25 engine testing



Common Engine Controller
Derived from J-2X

Proven Performance for Human Missions

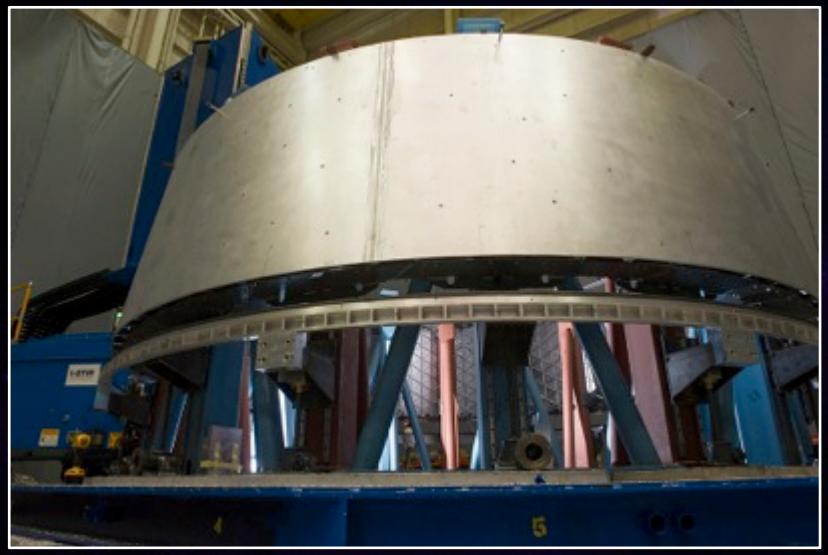
5-Segment Solid Rocket Booster Progress

Qualification Motor Testing Begins in 2013
QM Casting, July 2012

Development Motor Testing Completed
DM Test 3
September 8, 2011
ATK Promontory, Utah

Developing the World's Largest Solid Rocket Booster

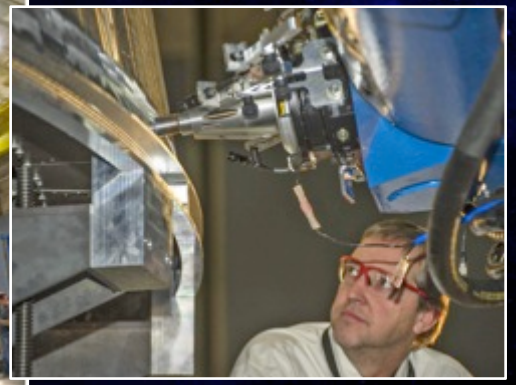
Multi-Purpose Crew Vehicle Stage Adapter (MSA) Progress



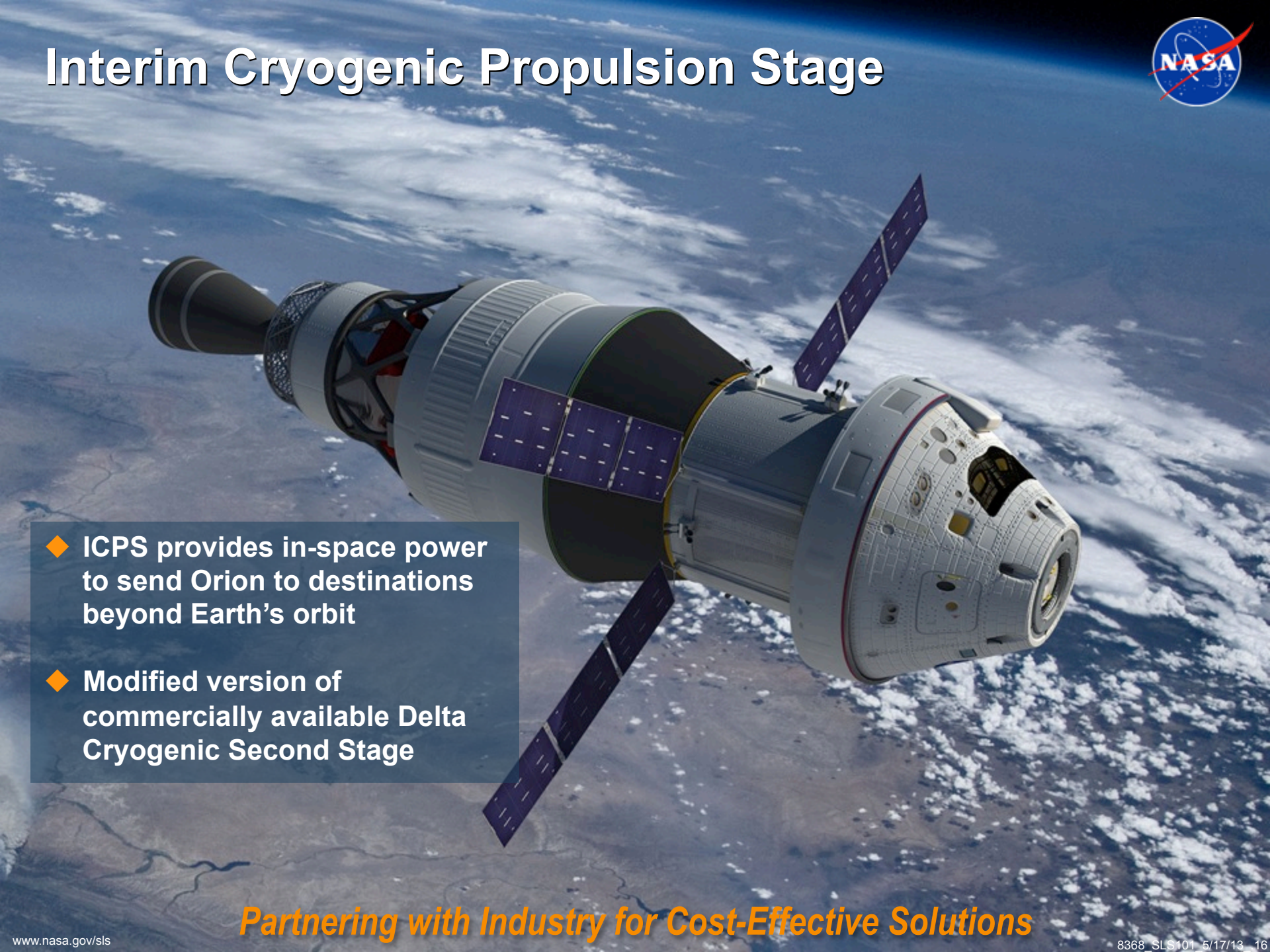
Production of MSA at Marshall Space Flight Center in early 2013, for Orion's Exploration Flight Test to Earth Orbit in 2014

Delivering MSA rings to Marshall in Dec 2012

Assembling the MSA pathfinder hardware in 2012



Interim Cryogenic Propulsion Stage



- ICPS provides in-space power to send Orion to destinations beyond Earth's orbit
- Modified version of commercially available Delta Cryogenic Second Stage

Partnering with Industry for Cost-Effective Solutions

SLS 130 metric ton Expanded View

Evolving to Mars-Class Capabilities

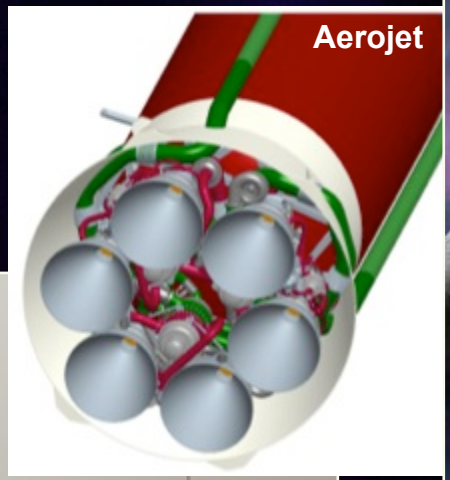
J-2X Engine: In Testing

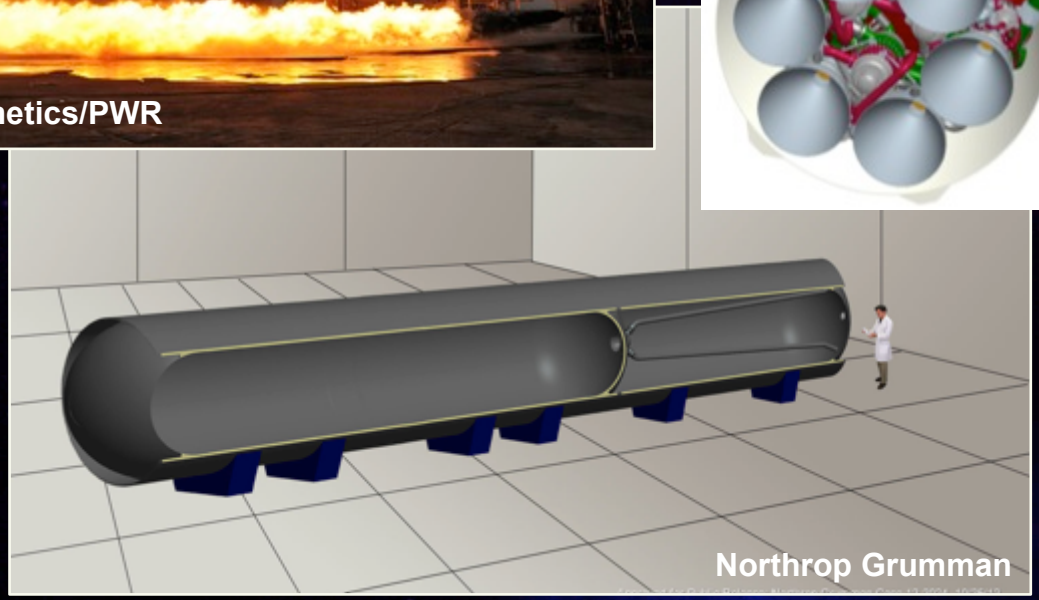
Technology Research & Development:

- Yielded Common Engine Controller for RS-25 Core Stage Engine
- Testing includes Selective Laser Melted engine part manufactured in days rather than weeks

Shortest Time to Full Power Level Ever Recorded

Advanced Research and Development

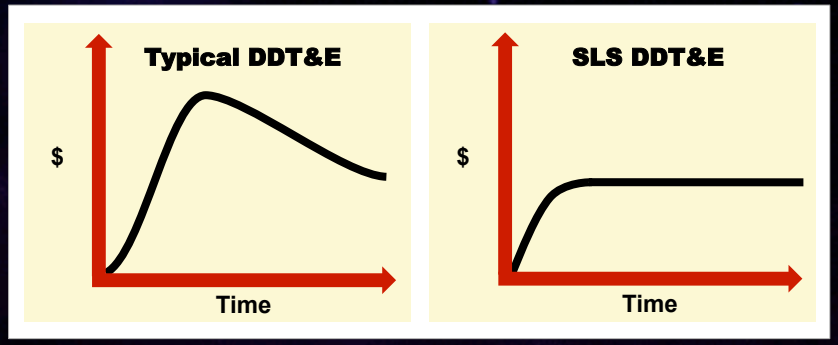


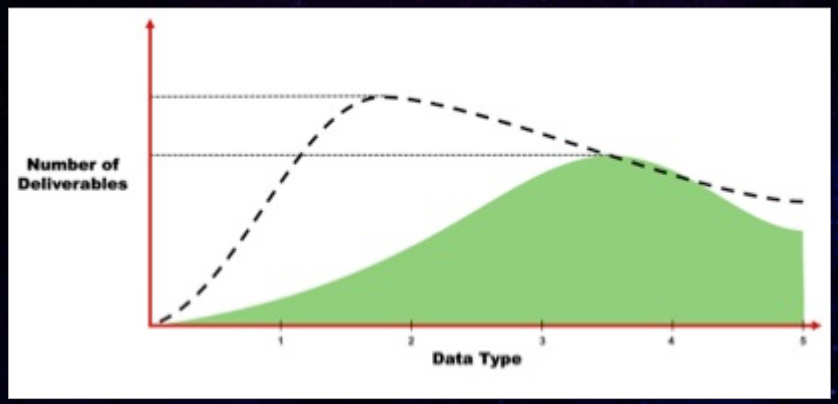


Enabling Affordable Performance Upgrades

Pursuing Affordability Solutions

- Lean, Integrated Teams with Accelerated Decision Making
- Robust Designs and Margins
- Risk-Informed Government Insight/Oversight Model
- Right-Sized Documentation and Standards
- Evolvable Development Approach
- Hardware Commonality

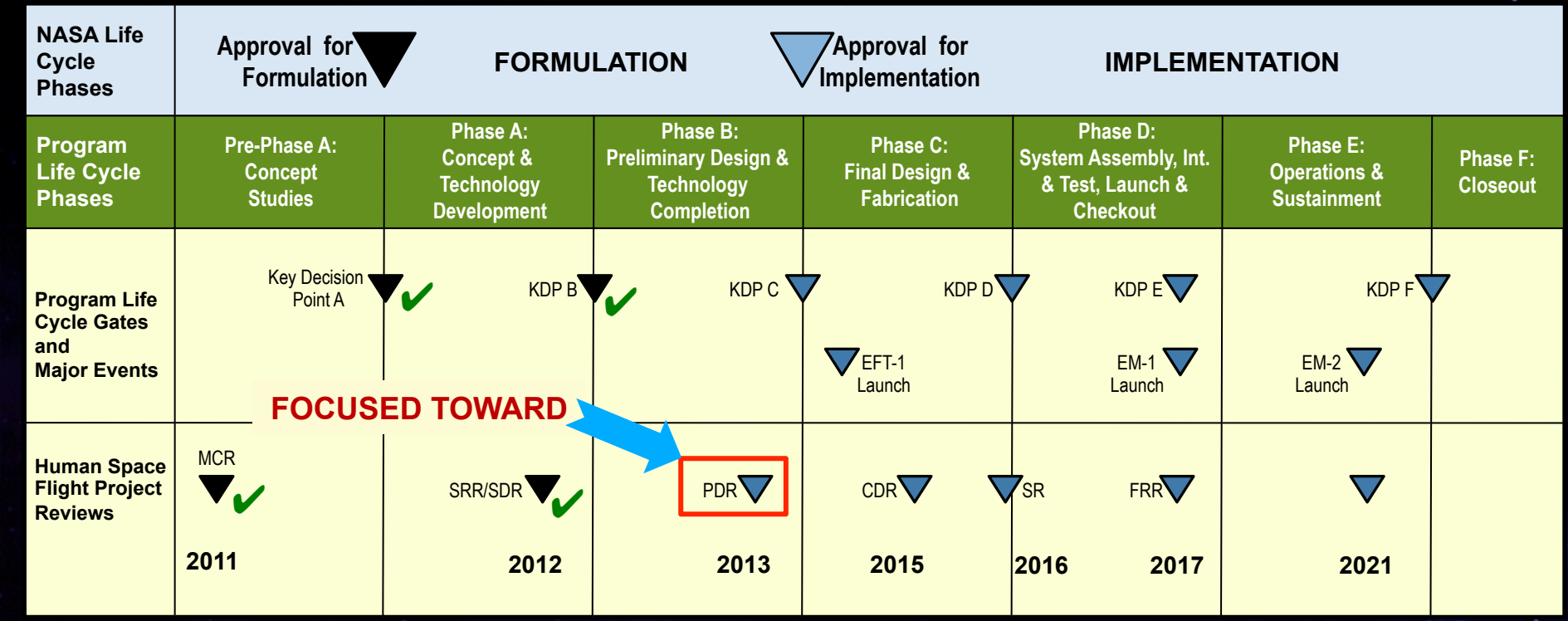




Focuses on the Data Content and Access to the Data

Sustainability through Life-Cycle Affordability

The Road to First Flight in 2017



[A] monumental effort … has gone into this Program…. I don't think anyone would have thought in September [2011] that this Program might be this far so fast.

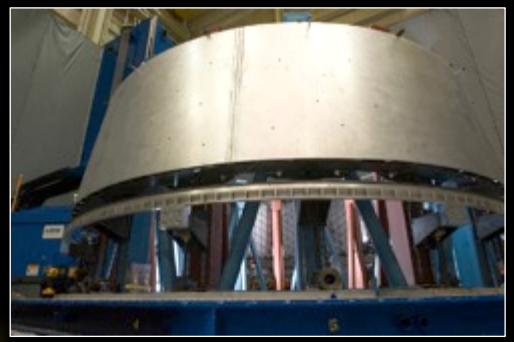
Leroy Cain, Chair
Standing Review Board
NASA Directorate Program Management Council
June 29, 2012

CDR: Critical Design Review	MCR: Mission Concept Review
EM: Exploration Mission	PDR: Preliminary Design Review
EFT: Exploration Flight Test	SIR: System Integration Review
FRR: Flight Readiness Review	SDR: System Definition Review
KDP: Key Decision Point	SRR: System Requirements Review

NASA's Space Launch System

On Course for First Flight in 2017

Engines
Tested selective laser melted part on J-2X at Stennis Space Center (March 2013)



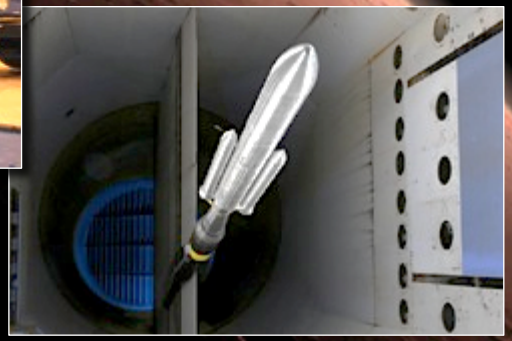
Spacecraft & Payload Integration
Produced Multi-Purpose Crew Vehicle Stage Adapter for 2014 Exploration Flight Test at the Marshall Space Flight Center (Feb 2013)

Boosters
Conducted Thrust Vector Flight Control Test at ATK in Promontory, UT (Jan 2013)

Preparing segmented ring tool for Core Stage construction at the Michoud Assembly Facility in New Orleans

Advanced Development
Conducted F-1 engine hot-fire testing at Marshall (Jan 2013)

Core Stage
Produced Core Stage test panel at AMRO Fabricating Corp. in South El Monte, CA (Dec 2012)



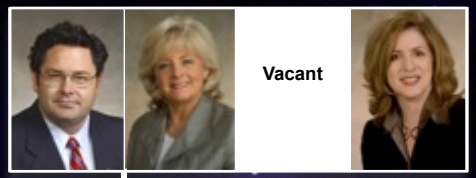
Systems Engineering & Integration
Tested buffet model in Langley Research Center's Transonic Dynamics Wind Tunnel (Nov 2012)

SAFE, AFFORDABLE, SUSTAINABLE

SLS Program Organization at MSFC

5/05/13

Hard line programmatic
Matrix relationship



Program Manager Todd May | Deputy Manager Jody Singer | Associate Program Manager Vacant | Assistant Program Manager Sharon Cobb

Chief Engineer (CE) Garry Lyles

Deputy CE John Honeycutt

Strategic Development Manager Steve Creech (XP01)

Chief Safety Officer (CSO) Rick Burt

Deputy CSO Dan Mullane

Program Integration Manager Mark Richards (XP02)

Program Integration Assistant Manager Johnny Heflin

Procurement Manager Earl Pendley

Program Planning & Control Manager Keith Hefner (XP03)

Deputy Manager Daryl Woods

Boosters Manager Alex Priskos (XP10)

Deputy Manager Bruce Tiller

Engines Manager Mike Kynard (XP20)

Deputy Manager Sheryl Kittredge

Stages Manager Tony Lavoie (XP30)

Deputy Manager Julie Bassler

Spacecraft & Payload Integration Manager David Beaman (XP50)

Assistant Manager Andrew Schorr

Ground Operations Liaison Manager Brian Matisak (XP60)

Assistant Manager Andy Warren

Advanced Development Office Manager Chris Crumbly (XP70)

Assistant Manager Fred Bickley

SLS Partnerships Nationwide

2012 Data

- Engaging the U.S. Aerospace Industry
- Strengthening Sectors such as Manufacturing
- Advancing Technology and Innovation

208 Subcontracts in 28 States

Exploring Space for America's Future

Summary

- Powerful, versatile, and capable vehicle for entirely new missions to deep space
- Vital to NASA's exploration strategy and the Nation's space agenda
- Safe, affordable, and sustainable
- Engaging the U.S. aerospace workforce and infrastructure
- Competitive opportunities for innovations that affordably upgrade performance
- Successfully meeting milestones in preparation for Preliminary Design Review in 2013
- On course for first flight in 2017

A National Infrastructure Asset

Somewhere, something incredible is waiting to be known.

— Carl Sagan

For More Information

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